3D reconstruction of the fortified entrance of the Citadel of Aleppo from a few sightseeing photos

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Built at the beginning of the 16th century by the final Mamluk sultan Al-Achraf Qânsûh Al-Ghûrî, the entrance to the Citadel of Aleppo was particularly affected by an earthquake in 1822, bombings during the Battle of Aleppo in August 2012, and a collapse of ramparts due to an explosion in July 2015. Even if compared to other Syrian sites, there are still enough vestiges to grasp the initial architecture, the civil war situation makes extremely difficult any "classic" process of digitization by photogrammetry or laser scanning. On this basis, we propose a process to produce a 3D model "as relevant as possible" only from a few sightseeing photographs. This process combines fast 3D sketching by photogrammetry, 3D modeling and texture mapping and relies on a corpus based on pictures available on the net. Furthermore, it has the advantage to be applicable to destroyed monuments if sufficient pictures are available.

Five photos taken in 2005 by a tourist archaeologist around the entrance were first used to generate a partial and poor quality point cloud with photogrammetry. The main elements of the inner gate and a part of the arched bridge are distinguishable on the point (Fig. 1). Because the architecture is fairly rectilinear and symmetrical, it has been possible to redraw in 3D most of the outlines by constantly comparing with what is visible on these first photos. The next step is the enrichment of the 3D model from the initial geometric basis and thanks to a corpus of photos available on the internet. This corpus was constituted from selection of pictures obtained with a search on Google Web Search and the keywords "Citadel" and "Aleppo". The selection took into account both the resolution of the images and the coverage of the items of interest and gathered 66 pictures.

The enrichment of the 3D model is performed through an iterative process made up of four main steps: (i) orthophoto extraction from some photos of the corpus (ii) 3D modeling from these orthophotos (iii) seamless texture extraction (iv) texture mapping.

The resulting 3D textured model is presented in Fig. 2. There are still some uncovered lateral areas, unreadable engraved wall writings, and some details are reconstructed naively, but the essential items, allowing to visually characterize the fortified entrance as a whole, have been reconstituted. The 3D model was first used to produce some renderings intended to obtain first reviews from archaeologists and architecture specialists, photos and complementary documents allowing correcting and filling the gaps. We wish to set a collaborative process to improve the model, based on an exchange with experts of the domain. The resulting model aims at feeding an interactive website dedicated to 3D display of heritage under threats. Other rendering of the model such as virtual reality or 3D printing could also be considered to share this testimony of our heritage. The application of this

methodology to other sites deserves further studies that would depend on the possibilities of photogrammetry, the architectural complexities and human means for 3D modeling.

Figure 1. Low quality point cloud

Figure 2. Rendering of the resulting 3D textured model